ROBOT VAC WITH RETRACTABLE POWER CORD

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CLAIM OF PRIORITY

[0001] This application claims priority to U.S. Provisional Application No. 60/454,934 filed March 14, 2003; U.S. Provisional Application No. 60/518,756 filed November 10, 2003; U.S. Provisional Application No. 60/518,763 filed November 10, 2003; U.S. Provisional Application No. 60/526,868 filed December 4, 2003; U.S. Provisional Application No. 60/527,021 filed December 4, 2003; U.S. Provisional Application No. 60/526,805 filed December 4, 2003 and this application incorporates by reference U.S. Application No. _____ entitled "Robot Vacuum" By Taylor et al., filed Concurrently. (Attorney Docket No. SHPR-01360USS)

FIELD OF THE INVENTION

[0002] The present invention relates to a robot vacuums.

BACKGROUND

[0003] Robot vacuums are new and growingly popular way to clean rooms. An example of a robot vacuum is the Roomba Vacuum for the iRobot Company. Since robot vacuums are typically powered by a battery, the cleaning units on the robot vacuums may not be strong enough to adequately clean a room. Conventional vacuums have relatively strong vacuum units to suck up dirt and other particulates. Because robot cleaners such as the Roomba are battery powered, they typically do not include such a powerful vacuum and may do an inadequate job cleaning rooms. It is desired to have an improved robot cleaner.

SUMMARY

[0003] One embodiment of the present invention is a robot system. The robot system comprises a robot cleaner including a cleaning unit and a motion unit. The system also includes a unit connected to the robot cleaner by an electrical cord to provide power to the robot cleaner. The robot cleaner cleans the room while connected to the unit and the power cord is wound in as the robot cleaner gets closer to the unit.

BRIEF DESCRIPTION OF THE DRAWINGS

[0004] Figure 1 is a diagram of a robot system including a robot cleaner of one embodiment of the present invention.

[0005] Figure 2 is a diagram illustrating a path of a robot cleaner unit in one embodiment of the present invention.

[0006] Figure 3 is a diagram of the path of a robot cleaner in one embodiment of the present invention.

[0007] Figure 4 is a diagram of an encounter of the robot cleaner with an object in one embodiment of the present invention.

DETAILED DESCRIPTION

[0008] Figure 1 illustrates a robot system **100**. The robot system **100** includes a robot cleaner **102** and a unit **104**, such as central unit. The robot cleaner **102** includes a cleaning unit **124** and a motion unit **120**. The cleaning unit **124** can be any cleaning unit including a sweeping unit, waxing unit or a vacuum unit. The unit **104** is connected to the robot cleaner by electrical cord **105** to provide power to the robot cleaner **102**. The robot cleaner can circle the unit to clean the room. The power cord can be wound in as the robot cleaner comes closer to the unit and can be wound out as the robot moves away from the unit.

[0009] In one embodiment, a power cord payout **106** is located at the unit 104. In another embodiment, the power cord payout **108** is located at the robot cleaner. The power cord payout can roll out the electrical cord **105**. In one embodiment, the power cord payout maintains some level of tension on the electrical cord **105**.

[0010] Figure 2 illustrates an embodiment which the robot cleaner **200** circles a central unit **202**. The central unit **202** is connected by another power cord **204** to an electrical socket

206. Since the robot cleaner **200** is electrically connected to the socket **206**, the robot cleaner **200** can have a powerful vacuum to adequately clean a room.

[0011] The electrical cord **204** can be a flat ribbon or other shape that can be taped down or otherwise placed to the floor in order to avoid the robot cleaner **200** from becoming entangled on the power cord **204**. As shown in figure 2, the power cord can be pulled in or out by a payout unit as the robot cleaner moves about the room. The power cord **208** can be connected to a central swivel at the central unit **208**, which rotates so that the electrical cord always to faces the robot cleaner **200**.

[0012] Looking at figure 1, the robot cleaner **102** can include sensors **122**. The sensors can be used to detect objects within the room, such as walls, furniture, etc. In one embodiment, the robot cleaner **102** includes a processor **110**. The processor can include a motion control unit **112** for controlling the operation of the motion unit **120**. The processor **110** can also include a feature detecting and mapping unit **114** to map the room. An indication of the power cord length and orientation with respect to the central unit can also be maintained as a part of the feature detection and mapping. If an object is detected in a room, the object can be mapped. The robot cleaner can avoid wrapping the cord around the object by not circling the object. Portions of the room in the object's "shadow" can be cleaned by the robot cleaner moving back and forth so as to not tangle the power cord.

[0013] Additional feature detection and mapping information can be provided by other orientation sensors, such as a sensor associated with a wheel on the robot cleaner. In one embodiment, the cleaning unit can use control software **118**. The cleaning unit control software **118** can be used for backing up the robot cleaner **102** detecting when the robot cleaner unit hits a snag.

[0014] In one embodiment, the robot cleaner **102** is able to detect an entangled condition. The processor **110** can monitor the robot cleaner to detect the entangled condition and then adjust the operation of the robot cleaner to remove the entangled condition. Robot cleaner **102** can become entangled at the sweeper or drive wheels. The entangled condition may be caused by a rug, string or other objects in the room.

[0015] The motor driving the wheels and sweeper will tend to draw a larger amount of spike in the current when the motor shaft is stalled or stopped. A back electromotive force (EMF) is created when the motor is turned by an applied voltage. The back EMF reduces the

voltage seen by the motor and thus reduces the current drawn. When a rise or spike in the current is sensed at the motor, the stall in the drive wheel, and thus the entanglement condition, can be determined.

[0016] An entangled condition can be determined in other ways, as well. In one embodiment, a lack of forward progress of the robot cleaner is used to detect the entangled condition. For example, when the robot cleaner is being driven forward but the position does not change and there are no obstacles detected by the sensors **122**, an entangled condition may be assume. The detection of the entangled condition can be use the position tracking software module described below.

[0017] In one embodiment, the current drawn by a motor of the robot cleaner **102** is monitored using a pin of a motor driver chip. The motor driver chip may include a pin that supplies a current proportional to the current through the motor. This current can be converted into a voltage by the use of a resistor or other means. This voltage can be converted in an analog-to-digital (A/D) converter and input to the processor. An example of a motor diver chip that includes such a current pin is the LM120H-Bridge motor driver chip. Other means to sence a current through the motor can alternately be used.

[0018] In one embodiment, when an entangled condition is sensed, the processor **110** adjusts the operation of the robot cleaner to remove the entangled condition. For example, the power to the sweeper can be turned off and/or the robot cleaner can be moved backward to remove the entangled condition. Alternately, the direction of the sweeper can be reversed. Once the entangled condition is removed, the operation of the robot cleaner can proceed. If one or more entanglements occur at a location, an obstacle can be mapped for that location and that location can be avoided.

[0019] Figure 3 illustrates the case when the robot cleaner reaches a wall. When the robot cleaner reaches a wall of the room. The robot cleaner can go into a wall following mode. The wall following mode can move the robot cleaner to the corners of the room or cleaning a portion along the wall and then continue the circling about the central unit.

[0020] Figure 4 illustrates an embodiment where the robot cleaner **400** gets partially entangled by an object. In one embodiment, the robot cleaner prevents the power cord from completely wrapping around an object **402** on the floor. In this embodiment, the robot cleaner uses the mapping and tracking functions to not wrap around the object. For example, contact

with the object can be determined by the tension in the power cord or by the change in direction of the robot cleaner. In one embodiment, the robot keeps track of its motion to determine direction changes caused by the power cord contacting objects on the floor. Keeping track of the direction can be done by monitoring a motion sensor such as a motion sensor associated with the motion unit of the robot unit. In one embodiment, the robot cleaner, once a contact is determined, will clean back-and-fourth behind the object **402** while ensuring that the power cord is not entangled by the object **402**.

[0021] One embodiment of the present invention is a robot cleaner including a cleaning unit and a motion unit. The robot system also includes a central unit connected to the robot cleaner by a power cord to provide power to the robot cleaner. The central unit is connectable to a power socket by another power cord wherein the robot cleaner is adapted to clean a room. The robot system includes a power cord payout.

[0022] The foregoing description of preferred embodiments of the present invention has been provided for the purposes of illustration and description. It is not intended to be exhaustive or to limit the invention to the precise forms disclosed. Many embodiments were chosen and described in order to best explain the principles of the invention and its practical application, thereby enabling others skilled in the art to understand the invention for various embodiments and with various modifications that are suited to the particular use contemplated. It is intended that the scope of the invention be defined by the claims and their equivalence.